Issue 5. Feasibility of various technological alternatives to provide last mile advanced telecommunications capability in rural areas.

There are a number of new technologies that currently provide, or promise to provide, broadband service. These include fiber to the home, third generation (3G) cellular, MMDS, LMDS, and broadband satellite service. The economic and technical feasibility for serving rural areas is discussed for each technology.[81]

Fiber to the Home

Fiber to the home can be considered as either a technological enhancement or a technological alternative. Both cable and telephone systems have been installing fiber fed distribution points in their networks. Extending that link to the home with fiber can be considered an enhancement to the existing system. If the entire system were built from scratch, however, it could be considered a technological alternative.

Neither approach has yet demonstrated an economic advantage over conventional coax and twisted-pair copper but that day seems to be fast approaching. The cost of installed fiber in the loop has dropped to the point where it is roughly the same as copper when doing a complete system rebuild or a new area build.[82] Because telephone plant lasts a long time and companies try to avoid rebuilds, fiber trials have generally been in new developments where the excess cost of a fiber system is primarily in the terminal equipment.

81. It should be noted that all the alternative technologies require the customer to provide the power for the equipment at his or her end. The monthly cost to power these devices may not be insignificant. More important, reliability of phone service, even with battery backup, can be affected if it is provided over one of these alternatives. During a power outage, a traditional phone system can rely on a standby generator, whereas a customer using one of these alternatives must rely on a battery that may have gone bad since the last outage. Also, batteries are generally short-term back-ups and cannot maintain reliable operation for the days or weeks of a weather-related emergency

82. The competitiveness of fiber direct-to-the home in extreme low-density areas can be illustrated through the FCC's current Synthesis Cost Model. This model, a tool for helping to determine universal service support for the large (non-rural) carriers, designs a hypothetical telephone system for the entire country in order to calculate what it would cost to build a telephone system today. The model designs a system as if there were no existing telephone system, except that it retains the location of the wire centers.

Because the model is a mechanism of universal service, it builds its hypothetical system so that it is advanced services ready for 100% of the customers. The model groups customers into clusters that can be served with the least plant. Each cluster is served either directly by the switch or, for the more distant customers, by a fiber feeder and its own digital carrier system. All the customers within the cluster are connected to the switch or carrier system with less than 18,000 feet of twisted pair copper.

Where there are fewer than ten customers in a cluster, it may be more cost-effective to build fiber direct-to-the-home rather than use the combination of fiber, carrier, and copper as designed by the Synthesis Cost Model. This is because, under the model, each cluster requires a fixed investment of $15,000 for carrier equipment, not counting land, building, and power. As an alternative, subscriber terminal equipment for fiber can be obtained today for approximately $1,500 per subscriber and eliminates the need for the $15,000 investment. Ironically, fiber may be most cost effective for the hardest-to-serve customers where new plant is being built.

MMDS

MMDS offers a last mile solution for rural areas, primarily as a technological alternative. While it is conceivable that existing MMDS television systems will be converted to digital broadband, it is far more likely that MMDS broadband will be offered primarily as a new service because the existing MMDS television customer base is so small.[83]

MMDS holds promise for rural areas because it can operate at a radius of up to 35 miles under the best circumstances (3,848 square miles). Based on trials and early implementations, MMDS broadband can reach remote customers within that radius as long as there are appropriate conditions, such as available spectrum and a clear line of sight. As with any terrestrial microwave system, MMDS signal coverage is affected by terrain, vegetation, and buildings. These problems are exacerbated at higher frequencies.

MMDS may have an advantage over wireline service in rural areas because its cost-to-serve is not quite as dependent on the exact location of the customer within the operating radius. In other words, the cost to serve a customer living six miles from the tower is hypothetically about the same as the cost to serve a customer living one mile from the tower. Cost can still be affected by distance, however. Systems operating at ranges approaching 35 miles require much higher towers due to the curvature of the earth and the cost of towers rises rapidly with their height.[84]

Economic considerations will play a role in determining where MMDS is deployed because MMDS operators may need a sizable customer base over which to spread their fixed costs. A new tower can cost between $200,000 and $1 million. According to certain equipment and systems providers, base station and data access equipment costs are about $200,000 to $400,000. Given these fixed costs, MMDS will more likely be deployed in larger towns or areas with high population densities that are not yet served by DSL or cable modems.[85]

In rural America, MMDS will likely be used to serve the rural countryside surrounding a non-rural town or a cluster of rural towns that can be served from one site. To date, MMDS is deployed in towns with populations as low as 6,000. If fixed costs drop or a new tower is not required, MMDS may also become feasible in isolated rural towns and the surrounding countryside.

83. There were approximately 821,000 MMDS video subscribers in June 1999, falling from one million subscribers in June 1998. Of these, 721,000 were analog TV subscribers. *See* Sixth Annual Report, *supra* note 27, at ¶87.

84. *See supra* note 52.

85. In smaller rural markets, cable modems and DSL may have an advantage over new technologies, such as MMDS, because they gain revenue from services other than broadband and can offer broadband service on an incremental cost basis. Additionally, telephone companies may be eligible for universal service support system for high cost lines. Given these advantages, MMDS is unlikely to enter a market already dominated by these existing utilities.

LMDS

While LMDS is generally considered a promising wireless "last mile" solution for broadband, it holds less promise than MMDS for serving rural areas. Because LMDS operates at such high frequencies, the transmit and receive antennas must be in close line of sight of each other. In addition, rain can more easily cause a loss of the LMDS, than the MMDS, signal. For these reasons, LMDS links are typically no longer than three or four miles, limiting its use to tightly clustered groups of users. A typical application is communication between a base station and an antenna on a building rooftop, which serves the occupants of a building.

LMDS will likely be deployed in cities and higher density towns. Touch America, the telecommunications subsidiary of The Montana Power Company, now offers commercial LMDS in Butte and Billings to government and business customers. It anticipates spending $15 million to build out its initial LMDS footprint in 25 cities.[86] The company explained, however, that it has no plans to build out to rural areas because of LMDS's limited range.

On the other hand, several smaller incumbent carriers are testing or deploying LMDS in areas that are at least partially rural. For example, Central Texas Cooperative, located in Goldthwaite, Texas, and South Central Telephone, located in Medicine Lodge, Kansas, are both trying LMDS for their customers.[87] Virginia Polytechnic Institute is also conducting research to determine LMDS' technical and financial viability in rural markets. The university, which won four licenses and has two wireless research centers, has created a testbed to evaluate the technology and its applications. The ultimate fate of LMDS as a rural solution will become more apparent through such trials.

Third Generation (3G) Wideband Cellular

Existing mobile wireless systems, whether analog or digital, cellular or PCS, are narrowband by design and cannot provide broadband services. Third generation wireless (3G) promises much more. Spectrum has not yet been allocated in the United States, but 3G could provide an alternative for some broadband applications.

There is no single definition of what constitutes 3G. Considerable attention has been focused on international agreements for an International Telecommunication Union standard, known as International Mobile Telecommunications - 2000, which is expected to provide:

- A wide range of data capabilities (multi-media, high-speed Internet connections, video conferencing).
- Operation in virtually every environment (indoor, pedestrian, vehicular, urban, and rural).
- World-wide connectivity available in a single device.

86. *See* www.mtpower.com/headlines/1999

87. Skip Richter, *Diving into LMDS*, Rural Telecommunications, July-August, 1999.

Under current proposals, there are three data rate standards. Two of these, portable at 384 kilobits/second and fixed at two megabits/second, meet the FCC definition of broadband. The third, a mobile standard, at 144 kilobits/second, does not. Other future mobile services offering lower rates than 3G are sometimes referred to as "2.5 G."

At present, any estimates of cost or deployment would be purely speculative. Given the sophisticated nature of a cellular operation which requires mobile handoffs from one site to another, the fixed costs per site may be significantly more than for a simpler fixed technology such as MMDS. And it must be remembered that fifteen years after cellular service was started in the United States, there are still rural areas where first generation cellular coverage is spotty or non-existent.

Broadband Satellite

Satellite systems offer another technological alternative to provide wireless broadband. These systems have an obvious advantage over terrestrial wireless systems in providing broadband to rural areas because they have a direct line-of-sight to most locations. Geo-stationary satellites have a line-of-sight to almost every location and low earth orbit multi-satellite systems are designed to have a line-of-site to every location above ground.

Satellites may therefore be an attractive alternative for remote locations that cannot be economically connected via other last-mile technologies. These systems are not constrained by distance and offer the opportunity to leap directly to broadband service without upgrading existing terrestrial communications infrastructure. Both factors make satellite systems especially promising for serving remote rural areas, such as towns and villages in Alaska and remote western deserts and mountainous areas, which have yet to be connected via land lines for technical and/or economic reasons.

Two-way satellite systems specifically designed for broadband data are mostly still in the planning phase. Companies, such as Teledesic, Skybridge, Orblink, Pentriad, Virtual Geo/VIRGO, Spaceway, CyberStar, Sky Station, and HALO and others, are promising to deploy broadband services. Appendix C provides a non-comprehensive list of prospective systems.

Broadband satellite systems can serve different groups of customers depending on the satellites' altitude above earth. Orbital altitudes include geo-stationary orbits (approximately 36,000 kilometers above earth), medium earth orbits (approximately 10,000 kilometers), and low earth orbits (approximately 1,500 kilometers). There are even proposals for aircraft-based platforms operating in the upper atmosphere at approximately 20 kilometers above the earth. The platform altitude has an effect on the coverage area, propagation delay, power requirements, and antenna requirements, among other things. These factors build a complex set of tradeoffs and drive the variety in system designs. The low earth systems are targeted more at individual users, along with larger business customers. The medium earth and geo-stationary systems are targeted more at large users and ISP providers with the end user attached via a local network.

The potential for broadband, two-way satellite systems will be come clearer in the next few years. Economic and technical considerations will play key roles in determining the success of satellite deployment. To begin with, the required investment is huge. Estimated costs for satellite systems range from $4 billion to more than $10 billion for global systems.[88] This high fixed start-up cost represents a substantial risk and has been prohibitively expensive for many companies to consider. The recent financial difficulties of several satellite systems have dimmed the expectations of some analysts that satellite might provide the key answer to last mile connections in rural areas. On the other hand, some observers are optimistic that broadband data satellites may represent an opportunity for satellite industry recovery.[89] While the bankrupt satellite systems emphasized voice communication, the broadband satellite systems may ride the crest of increasing global demand for data services.[90] An industry shakeout over the next few years will make the economic situation clearer.

Technical issues will also play a role. For example, satellite systems have long lead times. Most companies anticipate a three-year deployment horizon for their systems, with start-up around 2002. This means that much of the technology may be locked in years before the system is turned on. During that time, technologies are likely to change and competing technologies may become more desirable.

Lower orbit systems (where satellites circle the globe every 90 minutes to several hours) require many satellites and complicated hand-off systems since no satellite stays overhead for long. As more systems come on line, signal power could be restricted to limit interference.

Finally, delivery of broadband to individuals requires tremendous system capacity. The feasibility of satellites as a broadband delivery vehicle will depend upon bandwidth availability and the efficiency with which available bandwidth can be reused.[91] These constraints will ultimately determine how many customers a broadband satellite can serve.

For example, one of the proposed low-earth-orbit, multi-satellite systems, which will offer both data and voice, plans a total worldwide throughput capacity of 200 gigabits/second given the expected bandwidth in which it will operate. Assuming that no more than 20% of this capacity could be directed towards the United States at any one time,[92] this system could devote about 40 gigabits/second to America.

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88. Robert Norcross, *Satellites:The Strategic High Ground*, Scientific American, Oct. 1999, at 107.

89. Joseph Anselmo, *Can Broadband Industry Fix Space Industry Woes?*, Aviation Week and Space Technology, Nov. 8, 1999, at 96-97.

90. *Id.*

91. The primary way to increase a system's capacity is through the reuse of its operating bandwidth. For wireline systems, each new twisted pair, coaxial cable, or fiber is capable of reusing the spectrum of every previously installed wire. Terrestrial wireless systems, such as cellular mobile radio, add capacity by "cell division." By substituting several geographically dispersed lower power radios for a single higher power radio, they can split the cell into multiple cells, reusing the bandwidth in each non-adjacent cell.

When it comes to satellites, there are two methods of bandwidth reuse. One is through the use of multiple satellites with earth-based, directional antennae that receive a signal only from one satellite. The other is through the use of directional antennae on the satellite (spot beams) so that the signal is transmitted only to a limited geographical area, which allows reuse of the bandwidth in another area.

92. This is a generous assumption because the surface area of the United States is less than 2% of the earth.

What does this equate to in terms of the number of households served? Earlier, it was noted that cable providers offer their service from a node that serves between 350 to 700 TV customers' homes with the expectation that not every TV customer will take broadband. The broadband customers typically share a 27 megabit/second downstream channel. By extrapolation, if 27 megabits/second can serve 350 to 700 homes, 40 gigabits/second can serve about 1,500 times as many, or about 500,000 to one million homes.[93] This represents about one-half to one percent of the nation's households.

Thus, although such a system would be a valuable addition to the possible methods of providing broadband in rural areas, it would require many such systems to serve rural America even if the systems were devoted entirely to rural service. Broadband over satellite is an exciting prospect and represents an extremely attractive solution for the most remote areas but it must be recognized that even the multi-satellite prospective systems have limited capacity to meet rural needs.

<u>Summary Regarding Broadband Enhancements and Alternatives In Rural Areas</u>

With the exception of prospective satellite systems, the challenge for bringing broadband to rural America increases as the population density decreases. While both cable and DSL technologies promise to become more widely available in smaller and rural towns, DSL offers greater promise for reaching remote, out-of-town areas. Fiber and MMDS offer two other promising solutions for serving rural areas, although their potential for reaching remote rural areas is still questionable. Broadband satellite offers the most promising solution for remote, out-of-town customers if this technology can provide sufficient capacity and remain commercially viable.

It is important to remember that there is probably not one technological "silver bullet." Providing broadband service to rural America will likely require a combination of these, and perhaps other, technologies.

D. Effectiveness of Existing Mechanisms in Promoting Rural Deployment

Issue 6. Effectiveness of competition and universal service support mechanisms to promote the deployment of advanced telecommunications capability and the availability of advanced telecommunications services in rural areas.

Consistent with the Telecommunications Act, the Administration believes that, as a general principle, competition can accelerate the diffusion of broadband applications.[94] There are strong indications that competition has produced many benefits in such markets as long-distance

93. 40 gigabits/second ÷ 27 megabits/second = 1481.

94. Some evidence points to the salient effects of competition on broadband delivery. See, *e.g.*, Economics and Technology, Inc. (ETI), *Bringing Broadband to Rural America: Investment and Innovation in the Wake of the Telecom Act*, September 1999, and FCC, Sixth Annual Report. ETI found that a "wide array of broadband services delivered over a variety of technologies is now in the offing, and these services are already available in many parts of the country." *Bringing Broadband to Rural America* at 42. The FCC concluded that the "case studies [they examined] suggest that subscribers have benefited from 'head-to-head' competition" in terms of lower prices and upgraded systems." *Id.* at100.

telephone services, wireless telephony, and telecommunications equipment.[95] Less progress has occurred in local telephone service markets, where regulatory and legislative changes that promoted entry have been adopted much more recently than in other areas.[96]

Competition is succeeding in spurring broadband deployment in certain locations. In some markets, incumbent local exchange carriers are deploying DSL, for example, where cable operators have begun to offer cable modem service.[97] Wall Street analysts have also observed that the RBOCs have accelerated DSL deployment in certain markets where CLECs already offer such services.[98]

Other areas, however, are not yet seeing competition among broadband providers. It can be expected that competition will succeed first in large cities and metropolitan areas, and possibly later in less urbanized areas. As documented in this report, there is little evidence, to date, that competition among wire-based and terrestrial wireless-based systems has promoted near-term deployment of advanced telecommunications services in rural areas outside of towns.[99] For all the terrestrial technologies discussed in this report, per unit cost rises with decreasing population density, making service to homes and businesses outside of towns very expensive. One exception is for satellite systems, which are less sensitive to customer location but still require a sufficient customer base.

To ensure that all Americans are able to reap the benefits of the Information Age, Congress added the universal service provisions of Section 254 to the Communications Act, codifying what had formerly been public policy. The success of the policy and the law can be judged in part by the extent to which affordable, quality telecommunications service is available in rural areas, particularly the high cost areas outside of town. Properly crafted telecommunications

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95. *See, e.g.*, Council of Economic Advisers, *Progress Report: Growth and Competition in U.S. Telecommunications, 1993-1998*, released February 8, 1999.

96. *Id* at 15-25.

97. *See* Cable Services Bureau, FCC, *Broadband Today: A Staff Report to William E Kennard, Chairman, Federal Communications Commission*, Oct. 1999, at 27 (citing Lehman Brothers, *ADSL v. Cable Modems: And the Winner Is* . . . at 6).

98. *See, e.g.*, J.P. Morgan, Company Report on Covad Communications, Dec. 7, 1999, at 24.

99. The problem is particularly acute on Native American tribal lands, where such factors as difficult terrain, low-density population clusters, lack of economic infrastructure, and insufficient strategic planning are especially apparent. *See* Linda Ann Riley, Bahram Nasserharif, and John Mullen, *Assessment of Technology Infrastructure in Native Communities*, New Mexico State University, College of Engineering, Las Cruces, New Mexico (prepared for the Economic Development Administration, U.S. Department of Commerce) (July 1999) at 29. As a result of these obstacles, Native American reservations face some of the lowest telephone subscriber rates in the nation and are lagging behind many other rural areas in broadband service. According to the 1990 Decennial Census, approximately 53% of Native households on reservations and trust lands had telephones, compared to 94.8% of households nationwide. *Id.* at 16. With respect to broadband availability, the National Telephone Cooperative Association (NTCA) found that six (or 24%) of its 25 member companies responding to its survey reportedly provided broadband Internet service to some portion of an American Indian reservation or trust land. This study did not report how "broadband" was defined or what portion received broadband service. NTCA, *NTCA Members Serving Tribal Areas Survey Report*, December 10, 1999.

policies are critical both for the continued availability of ordinary telephone service as well as for the availability and deployment of advanced services in hard-to-serve areas.

Policymakers must make certain that the universal service mechanisms are carefully targeted to high cost areas. The FCC must ensure that Sections 254 and 706 are fully enforced, and that support is *specific, predictable, and sufficient* to preserve and advance universal service. Its definition of supported service must also be compatible with the concept of evolving improvements to service. NTIA and RUS are encouraged that the FCC is revisiting this definition, and hope that the findings in this report will be useful in that proceeding.[100]

For more than 60 years, policymakers have remained committed to the universal service concept that seeks to ensure ubiquitous, affordable telephone service in the United States. Cable, MMDS, and other alternative technologies might have greater penetration in rural areas if these providers were to become eligible for universal service support by offering telephone service. To date, there is little evidence that rural cable providers are moving in this direction, although MMDS and certain satellite companies will probably offer voice service.

As technology has brought new service features and capabilities, new policies have also been initiated that would make these advances more readily available to all Americans. In the section below, we describe some of the most important federal programs that support broadband deployment or may do so soon, either as an element of the program or as its primary focus.

1. Universal Service Support Mechanisms and Broadband

Funding for advanced services traces its origins to an evolving public policy. In 1993 through a vision statement, *The National Information Infrastructure: Agenda for Action*,[101] the Administration announced its goal to extend the concept to ensure that information resources are available to all Americans at affordable prices. Working with the Administration and other interested parties, Congress adopted as part of the Telecommunications Act of 1996 an expanded universal service policy.

Two primary components of the universal service mechanism include high cost support and support for schools, libraries, and rural health care. We believe, in addition to policies that promote competition, both components of the universal service mechanism are necessary for the deployment of broadband in rural America.

High Cost Support

For a number of years through mechanisms such as the high cost fund and access charges, the FCC has supported basic telephone service in high cost (primarily rural) areas. Other universal

100. *See* FCC, *Common Carrier Bureau Seeks Comment on Requests To Redefine "Voice Grade Access" for Purposes of Federal Universal Service Support*, CC Docket No. 96-45 (rel. Dec. 22, 1999) [hereinafter Public Notice on Voice Grade Access].

101. Information Infrastructure Task Force, *The National Information Infrastructure: Agenda for Action* (Sept. 15, 1993) at 8.

service mechanisms similarly target ordinary telephone service. For example, among the FCC's low-income assistance programs, *Link-up America* provides support for up-front installation charges, and *Lifeline Assistance* helps defray monthly telephone bills for local service.

There currently exists no direct support for the deployment of advanced services to U.S. households. As discussed below, however, support for advanced services has been considered while setting the definition of supported services and is tacitly expressed in the new universal service mechanism.

The definition of supported services, which is intended to evolve over time, is important to the deployment of broadband in rural America and even access to dial-up Internet services.[102] During the universal service proceedings before the FCC, some recommended that the definition of support include a specified performance level, such as 28 kilobits/second (V.34 standard) for modems that operate over a voice circuit.[103] The Commission determined that the definition of supported service should cover only voice grade access without a specific modem requirement.[104] On December 22, 1999, the Commission issued a Public Notice seeking comment in response to requests to redefine voice grade access.[105]

The high cost support system will also affect the degree to which broadband plant is available in rural areas. Prior to the breakup of the Bell System, high cost support was based almost entirely on implicit support within that system. The support mechanism was subsequently adapted to accommodate the breakup of the Bell System and deregulation of the toll industry. Under this system, the high cost fund has been used to support study areas where the average embedded cost exceeds the national embedded cost.[106] The support varied according to a schedule, with small carriers receiving proportionately more support than large carriers. This lesser support for large carriers was based on the assumption of implicit support flowing within a company from its low cost areas to its high cost areas just as had occurred earlier in the Bell System.

102. Section 254(c)(1) establishes generally that "[u]niversal service is an evolving level of telecommunications services that the Commission shall establish periodically under this section, taking into account advances in telecommunications and information technologies and services."

103. V.34 is the industry standard for modems commonly known as 28 K modems. It is designed to allow a maximum bit rate of 33.6 kilobits/second in both directions over a dial-up voice circuit. RUS, among others, argued that plant that is capable of supporting a 28 kilobit/second modem will generally support advanced services with additional equipment and that such plant serves the overwhelming majority of the residents of non-rural areas. Adopting a modem performance requirement as part of the definition of voice grade access would therefore ensure comparable service in rural and non-rural areas, as well as access to advanced services, as required by Section 254(b). In addition, RUS argued that supported plant should be capable of evolving to meet the anticipated changes in the definition of universal services. (www.usda.gov/rus/home/fccom.txt and www.usda.gov/rus/unisrv/fc7_10_27xp.htm)

104. *See* May 8 Order, *supra* note 5, at ¶ 64.

105. *See* Public Notice on Voice Grade Access, *supra* note 100.

106. In general, a study area, for purposes of universal service support, is an operating company's entire service area within a state.

In compliance with Congressional intent that support be explicit, the FCC recently adopted a new mechanism for the high cost areas served by non-rural local exchange carriers.[107] This system is based on forward-looking cost, *i.e.* what it would cost to build a telephone system today as estimated by a computer cost model (the Synthesis Cost Model).[108] Although the new mechanism is not designed to support broadband plant, the estimated cost is based on a broadband capable design, given the addition of DSL equipment.

E-Rate

Section 254 is also designed to encourage access to advanced telecommunications and information services for all public and non-profit elementary and secondary school classrooms, libraries, and rural health care providers. Schools and libraries are to be provided discounted telecommunications services, Internet access, and classroom connections. This is known as the education or "E-rate." Under the implementation method adopted by the FCC, this can include discounts on broadband applications if provided as part of a school or library's authorized technology implementation plan. Rural health care providers are to be provided rates comparable to urban rates for similar services.[109]

The E-rate program has been operating since 1998, with a second-year (July 1, 1999 through June 30, 2000) authorized funding level of $2.25 billion dollars. The program provides discounts of 20% to 90% based on the number of students eligible for the National School Lunch Program. Thus, the largest discounts are given to schools and libraries operating in poor communities. Currently, more than 90% of the nation's public schools and libraries possess Internet access, in some cases broadband, and 63% of U.S. classrooms are connected.[110]

The E-rate program has had a significant impact on rural areas, providing vital Internet connections in communities where deployment is slower.[111] The Kuspuk School District in Aniak, Alaska, was so remote that not a single one of the district's eight villages was accessible by road, and none of the eleven schools had Internet access. Through E-rate funds, however, Aniak was able to wire all of its school buildings and install satellite-based Internet connections at every school, enabling the children to get access to online learning resources.[112] The Nevada

107. *See Ninth Report and Order and Eighteenth Order on Reconsideration*, CC Docket Nos. 96-45, 97-160, FCC 99-306; and *Tenth Report and Order*, CC Docket Nos. 96-45, 97-160, FCC 99-304 (rel. Nov. 2, 1999) (effective January 1, 2000).

108. *See supra* note 82.

109. Section 254(h)(1)(B).

110. More specifically, 95% of the nation's public schools are connected. *See* National Center for Education Statistics, *Stats in Brief: Internet Access in Public Schools and Classrooms, 1994-99* (Feb. 2000). Approximately 93% of public libraries have such connectivity. *See* John Carlo Bertot and Charles McClure, *The 1998 National Survey of Public Library Outlet Internet Connectivity: Final Report* (Washington, D.C.: American Library Association, Office for Information Technology Policy).

111. In year one of the E-rate program, 43% of the funded applications were in rural areas and 22% of the amount allocated was for rural applications. In year two, 43.7% of the funded applications were in rural areas and 31.3% of the amount allocated was for rural applications. *See* Schools and Libraries Division national statistical analysis at www.sl.universalservice.org.

112. *See* EdLinc, *E-Rate: Connecting Kids & Communities to the Future* (May 1999) at 4

State Library system similarly benefited from e-rate funds. E-rate enabled all of the state's 23 public libraries to gain access to the Internet and provide Nevada's rural communities with the same access to information as those living in Las Vegas and Reno.[113]

In some cases, E-rate has enabled broadband applications in rural areas and small non-rural towns. E-rate funds helped defray the cost of upgrading to a fiber optics connection for School Union 49 in Boothbay Harbor, Maine and the West Point School District in West Point, Mississippi, for example.[114] Often, E-rate can be a magnet for broadband deployment by stimulating demand for broadband services.

2. Other Existing Sources of Financing Broadband Capabilities

U.S. Department of Commerce

Sources of funding for advanced service capabilities currently exist outside the universal service system. One source is grants awarded by NTIA's Technology Opportunities Program (TOP), formerly named the Telecommunications and Information Infrastructure Assistance Program (TIIAP), to rural as well as urban locations. TOP gives grants to public and non-profit sector entities for model projects demonstrating innovative uses of network technology. The program evaluates and actively shares the lessons learned from these projects to ensure that the benefits are broadly distributed across the country, especially in rural and underserved communities. NTIA officials believe that, driven by research efforts in academia, the federal government, and the private sector, new technology shows great promise to improve the quality of today's networks.

Specifically, TOP provides matching grants on a competitive basis to state, local and tribal governments, health care providers, schools, libraries, police departments, and community-based non-profit organizations. These grants are used to purchase equipment for connection to networks, including computers, video conferencing systems, network routers, and telephones; to buy software for organizing and processing information; to train staff, users, and others in the use of equipment and software; and to purchase communications services, such as Internet access; to evaluate the projects; and to disseminate the project's findings. TOP projects demonstrate how networks support lifelong learning for all Americans, help public safety officials protect the public, assist in the delivery of health care and public health services, and foster communication, resource-sharing, and economic development within rural and urban communities.

Since its inception in 1994, TOP has awarded grants in all 50 states, the District of Columbia, and the U.S. Virgin Islands. There have been 421 grants totaling \$135.8 million and leveraging \$203 million in local matching funds. In FY 2000, TOP's authorized funding for grants is \$12.5 million. Overall, approximately 65% of the grants go to projects supporting rural areas.

(www.edlinc.org/pubs/eratereport.html).

113. *Id.* at 29.

114. *Boothbay Harbor: Schools to Get Telecommunications Funds*, Portland Press Herald (July 29, 1999); *Central Will Be 1st to Go All Web*, Daily Times Leader (July 23, 1999).

For the FY 1999 grant competition, TOP emphasized its special interest in projects that proposed to use advanced network technologies to enhance the quality and efficiency of services delivered through non-profit organizations. Higher bandwidth networks will afford the opportunity to deliver high-resolution video to the desktop and emerging wireless networks will give end users greater flexibility in how and when they can gain access to information. Among the broadband applications submitted, TOP selected three that feature DSL capabilities. It should be noted that any grant award winner must meet several evaluation criteria on which each application is rated.

Over the years, TOP has supported projects that demonstrated the value of broadband networks in rural areas. For example, a 1994 grant to the State of North Carolina used the ATM-based North Carolina Information Highway to support telemedicine links between the emergency rooms of small rural hospitals and specialists at the state's teaching hospitals. The City of Aberdeen, South Dakota used high-speed links to support a variety of videoconferencing applications such as distance learning, telemedicine, and business teleconferencing and to provide Internet access for its residents.

Another Department of Commerce agency, the Economic Development Administration (EDA), has also supported broadband infrastructure development through its grant programs. EDA has funded a variety of projects that support technology-driven economic development in local communities. For example, EDA has helped fund industrial parks pre-wired with fiber optic cable, such as the March 1999 grant for $750,000 awarded to Cedartown, Georgia for a 200-acre high-tech industrial park. Other grants have helped support distance learning networks, technology business incubator facilities, and research parks. During FY 2000, EDA is giving priority consideration to projects that, among other things, emphasize the commercialization and deployment of technology.

U.S. Department of Agriculture

The Rural Utilities Service Telecommunications Program (Telecommunications Program) also provides two sources of funding for advanced telecommunications infrastructure in rural America. First, RUS provides loans for telecommunications infrastructure investment for commercial, non-profit, and limited liability companies that are providing or propose to provide local exchange telecommunications services to rural areas. The Telecommunications Program has been financing modern rural services for 50 years. Today, about 825 RUS-financed carriers serve 5.5 million rural subscribers over 866,235 route miles of line, for an average density of 6.27 subscribers per route mile or 4.72 subscribers per square mile.[115]

In 1993, Congress directed RUS to finance plant that is capable of transmitting and receiving one megabit/second. Over the last three fiscal years, RUS' telecommunications infrastructure loans totaling over $1.4 billion will provide over 783,000 of the nation's most rural households and businesses with the opportunity to subscribe to advanced services. The 591 rural exchanges built with these loans will have an average density of 5.73 customers per route mile, and the average exchange size is 1,325 customers. The average density of exchanges being upgraded to provide

115. RUS financed companies comprise about two-thirds of the rural carriers as defined in the Telecommunications Act. On a national basis, the population density in areas served by rural carriers is 13, compared to 105 in areas served by non-rural carriers. *See Rural Difference*, *supra* note 10, at 20.

advanced services capable plant is lower than the average density of all RUS-financed carriers (6.32 customers per route mile) demonstrating that such plant is practical in thinly populated areas.

RUS financing is supporting advanced services capable plant in even some of the most difficult-to-serve rural areas. One of the poorest counties in the United States is the home of the Pine Ridge Indian Reservation in South Dakota. The Pine Ridge exchange is served by the Golden West Telecommunications Cooperative (Golden West), which borrowed $65,948,658 from RUS in 1996 to upgrade its facilities to provide modern telecommunications services, including building advanced services capable loops. Facilities now in place in Pine Ridge offer DSL capability to all customers.

RUS also provides loans and grants for distance learning and telemedicine (DLT) initiatives to enhance learning and health care in rural schools, libraries and health clinics. Financing is provided primarily for end user equipment, including computer hardware and software, interactive video equipment and inside wiring. The DLT program has provided $68 million to meet the educational and health care needs for 252 projects in 43 states and two US territories. RUS financed organizations are encouraged to participate in these projects.

In Oklahoma, the Wheatlands Rural Educational Link Consortium (RELC) was created by eight school districts and one area vocational center to improve the quality of education in their communities. In 1995, RELC was awarded an RUS Distance Learning grant of $222,000. Pioneer Telephone Cooperative, an RUS financed local exchange carrier, also lent its financial support to the project.

The grant money was used to construct a fiber optic network connecting nine schools in eleven rural farming communities to the University of Oklahoma, Oklahoma State University, and Northwestern Oklahoma State University. Courses offered include foreign languages, music appreciation, world geography, and physiology. The state-of-the art system will provide telemedicine links with the Oklahoma University Health Science Center, and Baptist Medical Center in Oklahoma City.

In the past, RUS loans have helped Pioneer to build the advanced telecommunications infrastructure needed to accommodate the demand for new services such as distance learning networks. Pioneer is also providing the fiber optic service for RELC and other schools in northwest Oklahoma. Partnerships between RUS borrowers and grant recipients are enabling rural areas to achieve a quality of life equal to their urban counterparts in health care and educational opportunities.

U.S. Department of Housing and Urban Development

Another potential source of broadband assistance is the Housing and Urban Development's (HUD) Neighborhood Networks program. Neighborhood Networks is an initiative to help establish computer learning centers in FHA insured multifamily housing complexes; such centers may posses either broadband or narrowband applications. Programmatic success is dependent on the ability of the owner, management agent, and the residents to enter into partnership with members of their neighborhood and business community. The initiative started in 1996 to mitigate the reduction in welfare support for many residents in HUD assisted/insured multifamily housing. During the four years this initiative has been active, over 550 computer learning centers have been established serving more that 700 FHA insured apartment complexes and more than 150,000 low-income residents. With recent openings in Montana and South Dakota, the centers have expanded to all 50 states, the District of Columbia and Puerto Rico. Many centers have facilitated the graduation of residents from high school and college, the creation of micro-enterprises and businesses, and the development of healthier residents through on-line telehealth information.

U.S. Department of Education

Finally, the U.S. Department of Education provides computer and Internet access, broadband in some instances, and training for working-class families through its Community Technology Centers (CTC) program. In FY 1999, the Department of Education launched its CTC grants program. The program's stated purpose is to "promote the development of model programs that demonstrate the educational effectiveness of technology in urban and rural areas and economically distressed communities." Under the CTC initiative, the Department awards three-year grants on a competitive basis to state or local educational agencies, institutions of higher education, or other eligible public and private nonprofit or for-profit entities. In its inaugural year, the program awarded grants to 40 organizations in the amount of $10 million. For FY 2000, authorized funding is $32.5 million.

These initiatives not only give citizens access to technology, they can also stimulate demand for broadband infrastructure, in effect becoming anchor tenants. Once in place, these facilities and the technologies they encourage can become community resources.

3. Future Funding of Broadband Deployment

To ensure ubiquitous availability of advanced telecommunications services for those who desire them, adequate and targeted funding will be needed. This goal may not be quickly realizable unless access outside as well as inside the home is provided. As found in NTIA's July 1999 *Falling Through the Net* study, the information disadvantaged disproportionately turn to key neighborhood institutions such as schools and libraries for their Internet access.[116] A study sponsored by the National Science Foundation also confirms that Community Technology Centers are helping to bridge the digital divide. Of the users surveyed: 62 percent had incomes of less than $15,000; 65 percent took computer classes to improve their job skills; and 41 percent got homework help or tutoring at the center.[117]

Continuance of, and adequate funding for, all of the above programs will promote this vital public access to the Internet and other advanced services primarily outside the home. Being able

116. NTIA, U.S. Department of Commerce, *Falling Through the Net: Defining the Digital Divide* at 34-37, 42 (July 1999).

117. White House, Office of the Press Secretary, *The Clinton-Gore Administration: From Digital Divide to Digital Opportunity*, issued Feb. 2, 2000, at 3.

to use the Internet at home, of course, is more desirable. For purposes of ensuring access for rural households and businesses, RUS lending and grant programs must continue to receive the resources required to accomplish this important task.

Federal Initiatives

On February 2, 2000, President Clinton announced new budget proposals that, if adopted in full by Congress, would feature $2 billion in tax incentives to encourage private sector activities creating digital opportunities and $380 million in new and expanded initiatives to serve as a catalyst for public-private partnerships. More specifically, the proposals include:

1. $2 billion in tax incentives over 10 years to encourage private sector donation of computers, sponsorship of community technology centers, and technology training for workers.
2. $150 million to help train all new teachers entering the workforce to use technology effectively.
3. $100 million to create 1,000 Community Technology Centers in low-income urban and rural neighborhoods.
4. $50 million for a public/private partnership to expand home access to computers and the Internet for low-income families.
5. $45 million to promote innovative applications of information and communications technology for under-served communities.
6. $25 million to accelerate private sector deployment of broadband networks in under-served urban and rural communities.
7. $10 million to prepare Native Americans for careers in information technology and other technical fields.[118]
8. $100 million in new loan authority and $2 million in grants for RUS to target towards the provision of broadband and Internet service in rural areas.

Proposal number six explicitly would provide monies for broadband deployment in areas where such networks might otherwise not occur for many years; portions of the funding for most, if not all of the other seven proposals, could also include broadband applications.

State and Local Initiatives

In addition, state and local governments around the country are experimenting with new models and new forms of public-private partnerships to promote private sector investment in advanced telecommunications services. The State of Washington, for example, has passed legislation to promote broadband backbone in rural areas by encouraging local public utilities to sell Internet access on a non-discriminatory, wholesale basis over their fiber optic systems.[119] The State hopes that, by opening these networks, competing ISPs can more easily provide broadband service to remote homes and businesses.

118. *Id.* at 1-2.

119. John Borland, *State Looks To Power Companies for Rural Broadband,* Yahoo! News (March 28, 2000).

Several other states and local communities are using "demand aggregation" as a mechanism to attract the private sector investment needed to provide advanced services. The State of Colorado has introduced legislation to promote pooling telecom traffic among state agencies and local communities on the backbone network. These arrangements are intended to provide a market incentive to private providers to set up high speed connection points across the State. Recently, a consortium of telecommunications users in rural western Massachusetts called "Berkshire Connect" reached an agreement with Global Crossing and Equal Access Networks that will result in a 50 percent reduction in the cost of a T1 line (a service that provides 1.5 megabits/second). Berkshire Connect was able to do this in part by aggregating demand from users of telecommunications services in business, government, educational and non-profit institutions.

A number of cities and municipal utilities have also invested in establishing a broadband network to provide advanced telecommunications services to City agencies and residents. The City of LaGrange, Georgia, for example, financed and constructed a state-of-the-art two-way hybrid fiber coaxial network. The City recently announced that it would take the further step of providing residents with free Internet service using cable modem service.

While these projects may not necessarily be in rural areas of America, such innovative initiatives have the potential to further spur the deployment of advanced telecommunications capabilities to all regions of the nation.

Summary of Effectiveness of Competition and Universal Service Mechanisms

Competition has had varied success in bringing advanced telecommunications services to rural America. Broadband deployment has been more evident in the towns, relatively speaking, but little diffusion has manifested in the more remote rural areas. Current universal service mechanisms may help schools and libraries to gain affordable access to advanced services. Other sources of financing promote the spread of broadband capabilities to a range of geographic areas and groups. However, there is no assurance that competition, coupled with the current system of universal service, grant, and loan programs, can by themselves systematically provide affordable advanced services to rural America in the near term.

IV. RECOMMENDATIONS

In recent years, the United States has emerged as a leader in the Information Revolution. By some estimates, more than 100 million Americans have access to the Internet. Private sector investment in new competitive telecommunications companies has skyrocketed, and many of these companies are providing broadband telecommunications services and high-speed Internet access. Several million households have now subscribed to broadband Internet services, and that number continues to grow rapidly. Researchers are now developing networking equipment that will transmit over one trillion bits of information per second on a single strand of fiber, which will provide the infrastructure for applications that we can only dream of today.